WSDOT WETLAND MITIGATION SITES

OLYMPIC REGION

2001 MONITORING REPORT

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Executive Summary

Site Name	Success Standard	2001 Results	Mgmt Activities
SR 12 Black River	Less than 20% cover by invasive species through 2003	5% (CI 0.80 ± 0.35)	Weed control
	At least 80% survival of woody species by 2001	85% (CI 0.95 ± 0.06)	
	Wetland hydrology at least 12.5% of the growing season	Present	
SR 101 Sequim	70% survival of trees and shrubs in both the wetland and buffer area in 2001	76% (Total Census)	Weed control, seeding, mulching
	5 snags, 5 large woody debris piles, and 10 bat boxes present in 2001	Present	
	Exclude cattle from the site	Yes	
	75% of relocated Bell Creek will be a pool and riffle complex	79%	
SR 706 Ashford	75% survival of planted species in wetland in 2001	97% (CI 0.99 ± 0.04)	Replanting, mulching, brush removal
	75% aerial cover by FAC and wetter species in wetland in 2001	96% (CI 0.80 ± 0.20)	
	Soil saturation in most years (1999-2003)	Dry	
	Stable or increasing presence of wetland-dependant bird species (1999-2003)	Yes	
	Develop amphibian habitat (1999-2003)	No	

Introduction

History

Infrastructure improvements including highway construction projects, highway interchanges, and bridges have accompanied economic and population growth in the state of Washington. The Washington State Department of Transportation (WSDOT) routinely evaluates the potential for degradation of critical areas that result from these infrastructure improvements. WSDOT strictly complies with applicable federal, state, and local environmental regulations, including the Clean Water Act and the state "no net loss" policy for wetlands (Executive Order 89-10 1989). Generally, mitigation sites are planned when transportation improvement projects affect critical areas. The WSDOT Wetland Monitoring Program monitors these mitigation sites as a means of evaluating compliance with permit conditions and tracking overall development. Fifty sites were monitored in 2001 (Map 1).

Purpose

The purpose of this document is to report the status of Olympic Region WSDOT mitigation sites with respect to permit compliance and success standards for 2001 (Map 2). We rely on feedback from the users of this report to ensure its contents are clear, concise, and meaningful.

Process

Site monitoring typically begins the first spring after a site is planted. Sites are monitored for the time period designated by the permit or mitigation plan. The monitoring period generally ranges from three to ten years.

Monitoring activities are driven by site-specific success standards detailed in the mitigation plan or site permits. Data are collected on a variety of environmental parameters including vegetation, hydrology, and wildlife. After data analysis is complete, information on site development is communicated to region site managers to facilitate management activities on sites through an adaptive management process. Permitting agencies receive annual site reports that document site compliance with success standards and other permit conditions.

Methods

Methods used for monitoring mitigation sites change as site requirements and customer needs evolve. Quantitative data collection techniques presently in use are based on standard ecological and biostatistical methods.[1] The Monitoring Program's current methods include the following key concepts:

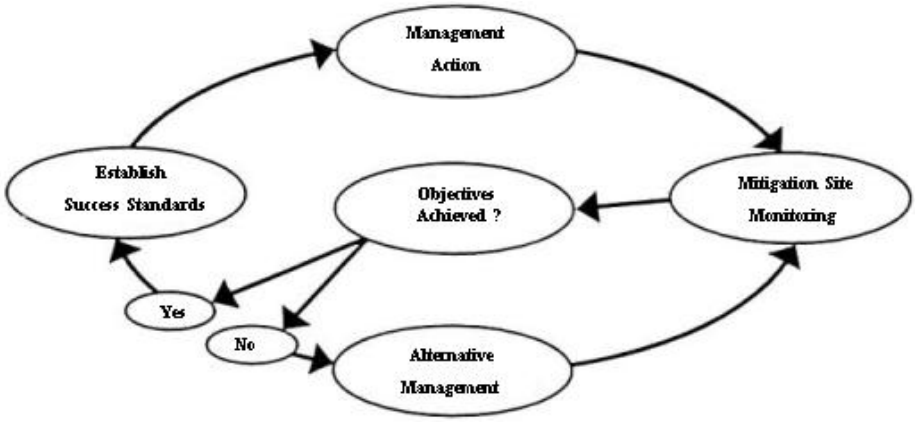
Objective-Based Monitoring

We collect data using a monitoring plan and sampling design developed specifically for each site. The monitoring plan and sampling design address success standards, contingencies, and other considerations as appropriate.

Adaptive Management

The adaptive management process is illustrated in Figure 1 (Elzinga et al. 1998). In this process: (1) success standards are developed to describe the desired condition; (2) management action is carried out to meet the success standard; (3) the response of the resource is monitored to determine if the success standard has been met; and (4) management is adapted if the standards are not achieved. Monitoring is a critical component of the adaptive management process, providing the link between success standards and management activities. Sound management decisions based on credible monitoring data can save resource management dollars when implemented in a timely fashion as part of an effective adaptive management strategy (Shabman 1995).

Figure 1. The Adaptive Management Process



[1]These methods are based on techniques described in Bonham (1989), Elzinga (1998), Krebs (1999), Zar (1999), and other sources.

Statistical Rigor

The monitoring program strives to eliminate subjectivity in data collection and increase the reliability of data analysis. Important considerations include appropriate sampling design, sampling resolution, random sampling procedures, and sample size analysis. Our goal is to provide customers with an objective evaluation of site conditions based on valid and reliable monitoring data.

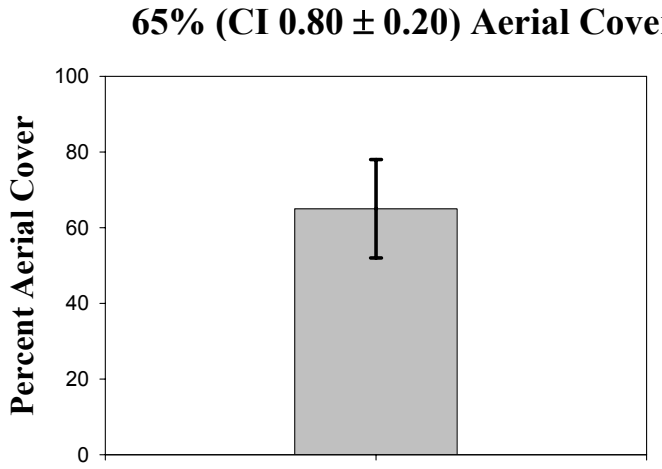
Success Standards

Site objectives and success standards are important elements of any mitigation plan. They indicate the desired state or condition of the mitigation site at a given point in time. Some mitigation plans also provide contingencies if a specific undesirable condition occurs. Contingencies typically initiate a management response when a particular threshold is not achieved, such as excessive cover by invasive species or insufficient cover by trees and shrubs.

Monitoring program staff thoroughly examines goals, objectives, success standards, and site permits to understand the desired site condition or characteristics to be measured. Six elements are sought in relation to each success standard to ensure measurability of the desired condition: species indicator, location, attribute, action, quantity/status, and time frame. Where one or more of the six elements is undocumented or unclear in the mitigation plan or permit, clarification is sought from region staff.

Sampling is required to address success standards unless a total accounting of the target attribute can be conducted efficiently and reliably. Sampling objectives are then developed to guide the monitoring process. Depending on the type of analysis to be done, sampling objectives may include a confidence level and confidence interval half width (Figure 2). These results are included in the individual site reports with the confidence

Figure 2. Estimated Cover Value Expressed with Confidence Interval Range



level and confidence interval noted as (CI X ± Y), where CI = confidence interval, X = confidence level, and Y = confidence interval half width. For example, an estimated

aerial cover provided by woody species shown as 65% (CI 0.80 ± 0.20) means that we are eighty percent confident that the reported value is within twenty percent of the true value. In this case, we are eighty percent confident the true aerial cover value is between 78% and 52% (Figure 2).

Vegetation Monitoring

For compliance purposes, aerial cover calculations include only areas covered by vascular plants (including floating-leaved species). Areas covered by thallophytes, bryophytes, structures, or aquatic vegetation are not included in aerial cover calculations. Scientific names, common names, hydrophytic plant indicator status, and nativity used in this report were obtained from the PLANTS Database (USDA 2001). Where invasive or noxious weeds are addressed, county specific listings in the State Noxious Weed List are referenced (Washington State Noxious Weed Control Board 2001).[2]

Sampling Design

When sampling is required, a sampling design is developed for the site or ecological area of interest. Sampling designs can vary from simple to complex depending on the number and type of attributes to be measured. Specific elements such as the size and shape of the site, the presence of environmental gradients, plant distribution characteristics, and the amount of time and resources available for monitoring are all factors that influence the sampling design. Elements of the sampling design may include the location of the baseline, orientation of transects, and the number and type of sample units to be used. A basic diagram showing the sampling design is included in mitigation site reports where appropriate. These drawings are general representations of the actual sampling designs and do not include specific details.

The quantitative vegetation methods described below are generally employed within a sampling design framework consisting of a baseline with transects extending from it across a site (Figure 3). Depending on the sampling objective and site characteristics, transects may vary in number, length, and width of interspersion. Sampling transect locations can be determined by using a simple random sampling method, systematic

[2] In some cases, other nuisance species may be included in invasive cover estimates.

Figure 3. Baseline and Sampling Transects

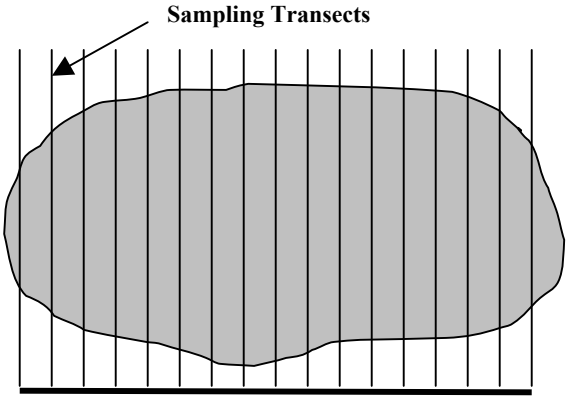
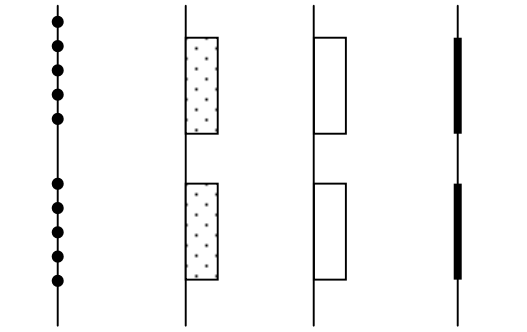


Figure 4 (a-d). Sampling Transects and Sample Units



random sampling method, stratified random sampling method, or restricted random sampling method. Sample units appropriate to one or more of the methods described below are randomly located on or adjacent to the sampling transects (Figure 4 a-d).

The Point-Line Technique

The point-line technique (Bonham 1989; Elzinga et al. 1998) is used where vegetative cover is the attribute of interest. Application of this method involves randomly locating sample units consisting of fixed sets of points along sampling transects (Figure 4a). Tools used to collect point-line data include point-intercept devices, pin flags, and densitometers. Using one of these tools, point locations are identified and all target vegetation intercepted by the point locator is recorded. If no target species are encountered on the point, bare soil, non-vascular plant, or habitat structure is recorded as appropriate. Cover is determined based on the number of hits of the target vegetation divided by the total number of points on each sample unit. The mean percent aerial cover value and standard deviation are calculated from the sample, and sample size analysis is conducted. Results are evaluated against the success standard and sampling objective.

The Point-Frame Technique

Point-frames are another tool that can be used to measure vegetative cover (Bonham 1989; Elzinga et al. 1998). A point frame is a rectangular frame that houses a number of points collectively serving as a sample unit (Figure 4b).[3] The sample unit can be lowered onto herbaceous vegetation and hits recorded where target vegetation intercepts point locations. The number of hits on target vegetation is divided by the total number of point locations on the sample unit to determine a percent aerial cover value. As with the point-line method, a mean percent aerial cover value and standard deviation are generated for the sample, and sample size analysis is performed.

[3] The WSDOT Monitoring Program typically uses a frame formed with polyvinyl chloride (PVC). Strings span the frame lengthwise and points are marked on the strings using a standard randomization method.

Survival and Density Estimates

To measure survival or density of planted trees and shrubs in an area, quadrat sample units can be randomly located along sampling transects (Bonham 1989; Elzinga et al. 1998). Quadrat width and length is based on characteristics of the vegetative community and patterns of plant distribution. Quadrats are typically located lengthwise along sampling transects (Figure 3c). Once the placement of the quadrats has been selected, plants are recorded as alive or dead. The success standard or contingency threshold can be addressed with a mean percent survival estimate of plantings, or a density per square meter of living plantings as appropriate. Sample size is analyzed to address the sampling objective.

Line Intercept

Cover data for the woody species community is collected using the line intercept method (Bonham 1989; Elzinga et al.1998).[4] Line segments, serving as sample units, are randomly located along sampling transects (Figure 4d). All woody vegetation intercepting a tape measure stretched the length of each sample unit is identified and the length of each canopy intercept recorded. The sum of the canopy intercept lengths on each sample unit is divided by the total length of each sample unit to calculate aerial cover values. Data are analyzed to address the success standard and sampling objective.

Sample Size Analysis

With each of the above methods, sample size analysis is performed to ensure that an adequate number of sample units are obtained. For data reported in this document, the following equation for estimating a single population mean or a population total within a specified level of precision was used to perform this analysis (Elzinga et al. 1998).

$$n = \frac{(z)^2(s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[5]
n = unadjusted sample size

A sample size correction to n is necessary for adjusting "point-in-time" parameter estimates.[6] It is the adjusted n value that reveals the number of sample units required to report the estimated mean value at a specified level of confidence. In this document, site reports indicate whether a sufficient number of sample units were obtained to achieve the sampling objectives based on adjusted n values.

[4] Depending on site conditions and other considerations, woody cover data is also collected using the point-line method and a densitometer.
[5] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.
[6] Adjusted n values found in this report were obtained using the algorithm for a one-sample tolerance probability of 0.90 (Kupper and Hafner 1989; Elzinga et al 1998).

Wildlife Monitoring

Bird Monitoring

Sites that require bird monitoring receive three to four bird surveys conducted from April through June each year. The point count method (Ralph et al. 1993) is used to document species richness and relative abundance.

Species diversity indices (H) are calculated for each data set using the Shannon-Wiener function (Krebs 1999). A mean annual species diversity index is calculated for each site.

$$H' = -\sum_{i=1}^{s} (p_i)(\log p_i)$$

H' = index of species diversity
s = number of species
p_i = proportion of sample belonging to ith species

The following t test is used to test the null hypothesis that diversity indices from different years are equal (Zar 1999).

$$t = \frac{H'_1 - H'_2}{S_{H'_1 - H'_2}}$$

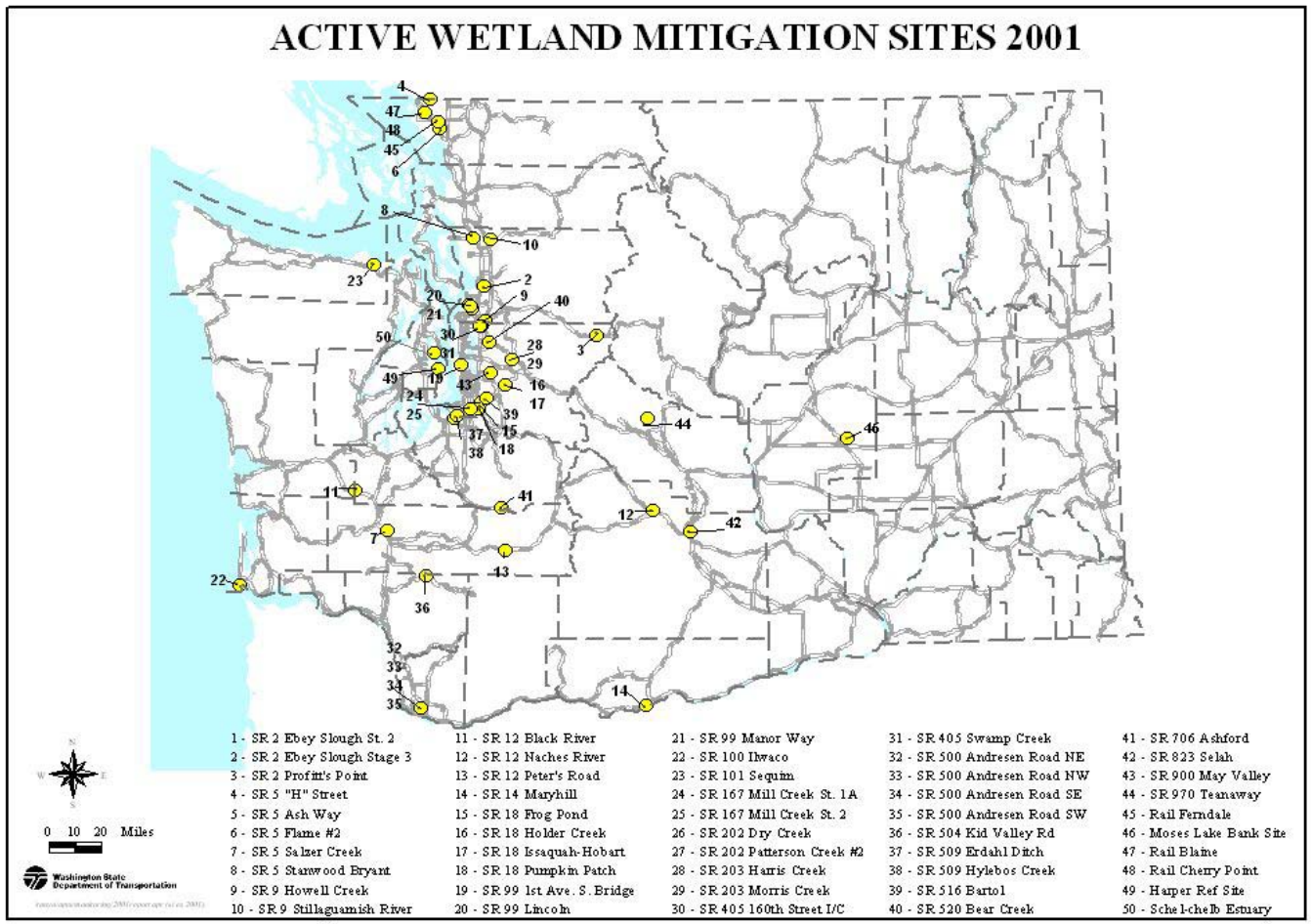
H' = index of species diversity
$S_{H'_1 - H'_2}$ = standard error of the difference between species diversity indices H'_1 and H'_2

Amphibian Monitoring

For sites that require amphibian monitoring, data are collected using methods adapted from Olson et al. (1997). Methods include funnel trapping on sites with a water depth of one decimeter or greater. Call surveys and area searches are used to assess terrestrial components of mitigation sites without standing water.

Incidental wildlife observations are recorded during all site visits.

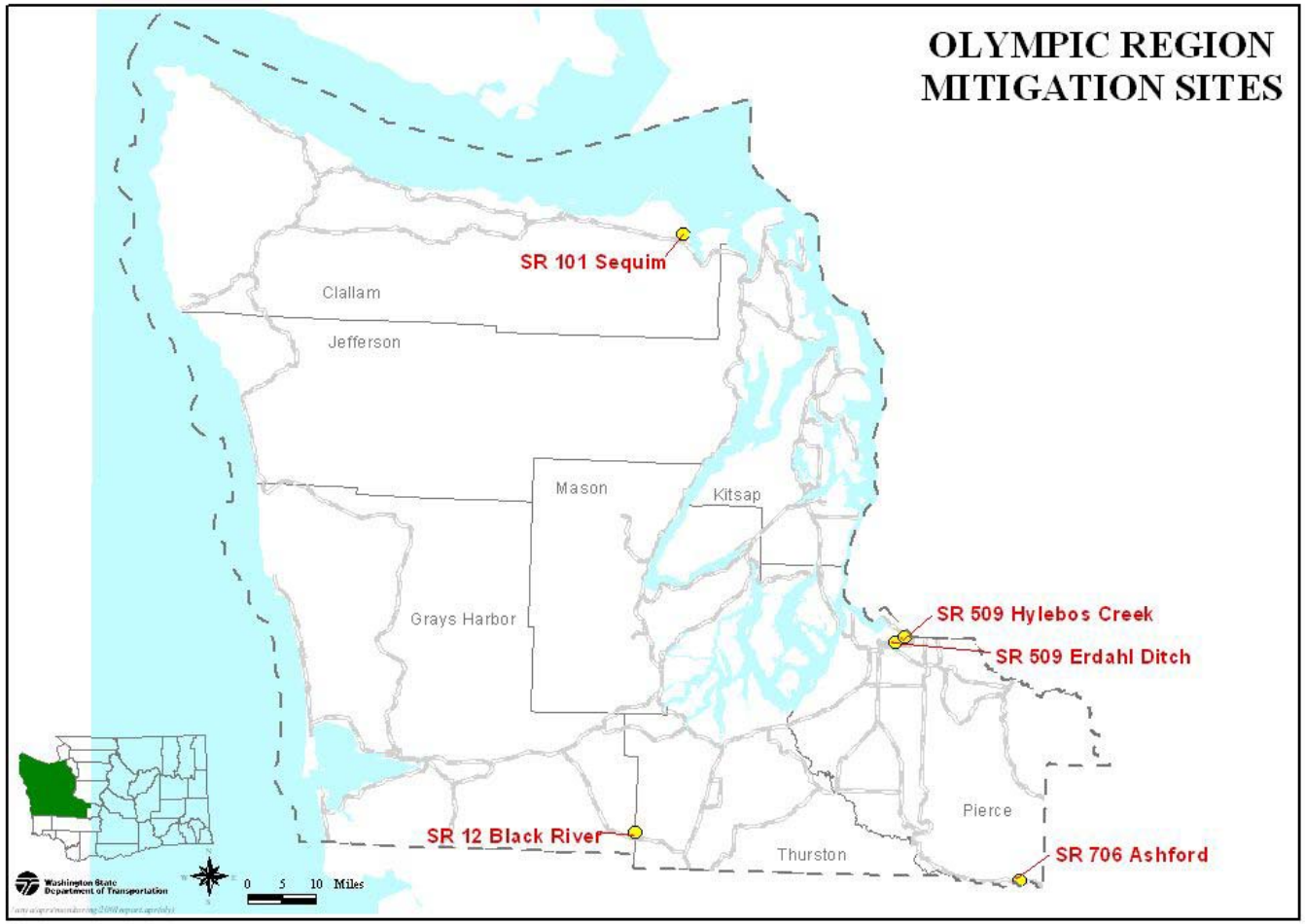
Map 1: WSDOT Mitigation Sites Monitored in 2001



Map 1: WSDOT Mitigation Sites Monitored in 2001

2001 Monitoring Report

Map 2: Olympic Region Mitigation Sites Monitored in 2001



Map 2: Olympic Region Mitigation Sites Monitored in 2001

SR 12 Black River, Thurston County

Summary

Site Name	Success Standard	2001 Results	Mgmt Activities
SR 12 Black River	Less than 20% cover by invasive species each year through 2003	5% (CI 0.80 ± 0.35)	Weed control
	At least 80% survival of woody species by 2001	85% (CI 0.95 ± 0.06)	
	Wetland hydrology at least 12.5% of the growing season	Present	

The following report summarizes project activities completed by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program at the SR 12 Black River mitigation site in September 2001. Monitoring activities include vegetation surveys and a qualitative assessment of the site with respect to third year success standards.

Site Information

Site Name	Black River
Project Name	SR 12 Vicinity Black River Br. & SR 12 Vicinity Moon Rd.
Permit Number	SSDP-98-0882
Permitting Agency	Thurston County SEPA/Shoreline Section
Location	SE/4 Section 27, T 16 N, R 4 W, Thurston County
Monitoring Period	2000 to 2004
Year of monitoring	2 of 5
Area of Project Impact	0.77 ha (1.92 ac)
Type of Mitigation	Creation/Enhancement/Preservation
Area of Mitigation	3.04 ha (7.51 ac)

Success Standards and Sampling Objectives

Success standards were developed from the *SR 12 Vicinity Black River Bridge & SR 12 Vicinity Moon Road Combined Conceptual Wetland Mitigation Plan* (Russell 1998). Companion sampling objectives follow where appropriate. A complete text of the success standards for this site is presented in Appendix A.

Success Standard 1

Cover of reed canarygrass, or other invasive species may not exceed 20% of the total wetland area at the SR 12 Black River mitigation site at any time during years one through five (2000-2004).

Sampling Objective 1
To be 80% confident the mean aerial cover estimate of invasive species at the SR 12 Black River mitigation site is within 20% of the true cover value.

Success Standard 2
Vegetative success at the SR 12 Black River mitigation site must equal or exceed 80% survival of planted trees and shrubs by the end of year three, or additional planting (and monitoring) to achieve such (2001).

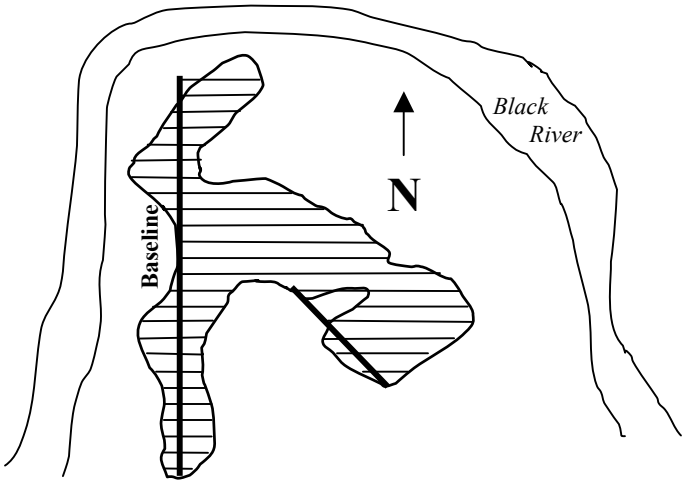
Sampling Objective 2
To be 80% confident the mean survival estimate for planted woody species at the SR 12 Black River mitigation site is within 20% of the true value.

Success Standard 3
Hydrology (within 12 inches of the soil surface) within the wetland creation area must be present for at least 12.5% of the growing season (2001).

Methods

To evaluate the vegetative community, 25 temporary sampling transects were established using a systematic random sampling method. Transects were extended east to west from baselines located on the west side of the site (Figure 5).

Figure 5. SR 12 Black River Mitigation 2001Site Sketch



Woody species survival data were collected from 42 quadrats (1 × 20m) randomly positioned along sampling transects across the site. Planted trees and shrubs observed within the sample units were identified to species and recorded as alive or dead.

Sample means and standard deviations were calculated from both point-line and quadrat sample data. Sample size analysis was conducted to determine if sufficient sampling had been completed to achieve the sampling objectives. The following equation was used to perform these analyses (Elzinga et al. 1998).

$$n = \frac{(z)^2(s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[7]
n = unadjusted sample size

To evaluate wetland hydrology for Success Standard 3, hydrological field indicators were recorded during site visits in April and September 2001.

Results and Discussion

The estimated aerial cover provided by invasive species was 5% (CI 0.80 ± 0.35), well below the 20% threshold specified in Success Standard 1. Invasive species recorded on site include *Phalaris arundinacea* (reed canarygrass), *Cirsium arvense* (Canadian thistle) and *Rubus armeniacus* (Himalayan blackberry).

Survival of planted woody species was estimated to be 85% (CI 0.95 ± 0.06). *Alnus rubra* (red alder) saplings have colonized large areas of the mitigation site contributing to the developing tree and shrub community (Figure 6).

Figure 6. SR 12 Black River (September 2001).

Depressed areas on site were inundated to a depth of one decimeter in April 2001. The low elevation of the site and proximity to the Black River, suggests that the intended wetland hydrology is present in most years (Success Standard 3).

Management Activities

Ongoing weed control efforts are focused on the eradication of *P. arundinacea,*

[7] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

Senecio jacobaea (tansy ragwort) and *Rubus* spp. (blackberry) in the wetland zone and along the mitigation site perimeter. Invasives were removed by spot application, hand removal, brush cutting, and mowing. A silt fence was removed and plantings were watered.

SR 101 Sequim, Clallam County

Summary

Site Name	Success Standard	2001 Results	Mgmt Activities
SR 101 Sequim	70% survival of trees and shrubs in both the wetland and buffer area in 2001	76% (Total Census)	Weed control, seeding, mulching
	5 snags, 5 large woody debris piles and 10 bat boxes present in 2001.	Present	
	Exclude cattle from the site	Yes	
	75% of relocated Bell Creek will be a pool and riffle complex**.**	79%	

The following report summarizes project activities completed by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program at the Sequim wetland mitigation site in June 2001. Activities include a survival assessment for all woody species plantings, a tally of habitat structures installed, and measurements of pools and riffles in Bell Creek.

Site Information

Site Name	SR 101 Sequim
Project Name	SR 101 Sequim Bypass Corridor
Permit Number	Not Available
Permitting Agency	Not Available
Location	Clallam County, Washington
Township/Range/Section	T.30N/R3W/S23, S24
Monitoring Period	2001-2011
Year of Monitoring	1 of 10
Area of Project Impact	6.41 ha (15.84 ac)
Type of Mitigation	Preserve/Restore/Enhance
Area of Mitigation	23.25 ha (57.45 ac)

Success Standards and Sampling Objectives

The first year success standards listed below were excerpted from the *Sequim Bypass Corridor Environmental Mitigation Plan* (Ward and Schlatter 1997). A complete text of the success standards for this site is presented in Appendix B.

Success Standard 1

Achieve a minimum of 70% survival of tree and shrub plantings by the end of Monitoring Year 1 (2001) on the site in both the wetland and buffer area.

Success Standard 2

Install, by the end of Monitoring Year 1 (2001), a minimum of five snags as perch trees, a minimum of five large woody debris piles and at least ten bat boxes.

Success Standard 3
By the end of Monitoring Year 1 (2001), 75% of relocated Bell Creek will be a pool and riffle complex.

Success Standard 4
Install a minimum of 20 in stream structures to provide cover for fish by Monitoring Year 1 (2001).

Success Standard 5
Exclude cattle from the mitigation site (2001).

Methods
A census for survival of woody plantings was conducted over the entire site. Plantings were identified and recorded as alive, stressed, or dead.

Habitat structures and bat boxes were counted. A visual inspection of each bat box was conducted by shinning a light inside the box in order to determine presence of bats or guano.

The total length of the relocated Bell Creek was measured. Measurements include the length of each pool, riffle, and glide. In-stream structures were counted.

Observations were made to determine the condition of the fence, and to evaluate the site for evidence of cattle.

Results and Discussion
Survival of planted tree and shrub species was 76%, exceeding the requirement of 70% specified by Success Standard 1. *Thuja plicata* (western red cedar) plantings suffered stress and high mortality rates. Other planted species are becoming well established.

The requirement for habitat structures stated in Success Standard 2 has been met. A total of 12 large woody debris piles, five snags, and ten bat boxes were counted. Inspection of each bat box did not yield any present evidence of use.

Bell Creek has a 79% pool and riffle complex, exceeding the 75% requirement stated in the Success Standard 3 (Figure 7). Glides cover the remaining 21% of the stream length. There were 37 habitat structures in the stream with no washouts observed, thus satisfying Success Standard 4.

Figure 7. **Bell Creek, SR 101 Sequim (May 2001).**

Observations throughout the site show no evidence of cattle. The gate was intact and the fence was undamaged along the perimeter of the site (Success Standard 5).

Management Activities

The Washington Conservation Corps performed maintenance activities on the site in May and June, including seeding, brush cutting, watering, mulching, and noxious weed control. Targeted weeds include *Conium maculatum* (poison hemlock), *P. arundinacea*, *Dipsacus follonum* (Fuller's teasel), *Senecio jacobia* (tansy ragwort), and others. Invasives were removed by spot application, hand removal, brush cutting, and mowing. Table 1 below contains a list of woody species that were replaced in April 2001.

Table 1 **Replanted woody species at the SR 101 Sequim mitigation site (2001)**

Species Name	Number of Plants Installed
Cornus sericea (red-osier dogwood)	400
Alnus rubra (red alder)	200
Symphoricarpos albus (snowberry)	100
Thuja plicata (western red cedar)	200
Pseudotsuga menziesii (Douglas fir)	80
Rubus spectabilis (salmonberry)	50
Rosa nutkana (Nootka rose)	50

SR 706 Ashford, Pierce County

Summary

Site Name	Success Standard	2001 Results	Mgmt Activities
SR 706 Ashford	75% survival of planted species in wetland in 2001	97% (CI 0.99 ± 0.04)	Replanted, mulched, brush removal
	75% aerial cover by FAC and wetter species in wetland in 2001	96% (CI 0.80 ± 0.20)	
	Soil saturation in most years (1999-2003)	Dry	
	Stable or increasing presence of wetland-dependant bird species (1999-2003)	Yes	
	Develop amphibian habitat (1999-2003)	No	

The following report summarizes project activities completed by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program at the SR 706 Ashford mitigation site in July 2001. Monitoring activities include vegetation and wildlife surveys and a qualitative assessment of the site with respect to third year success standards.

Site Information

Site Name	SR 706 Ashford
Project Name	SR 706 305th Avenue East to Anderson/Kernahan Road
Permit Number	95-4-00282
Permitting Agency	USACOE
Location	East of Ashford, Pierce County, WA
Monitoring Period	1999 to 2003
Year of monitoring	3 of 5
Area of Project Impact	0.049 ha (0.12 ac)
Type of Mitigation	Creation
Area of Mitigation	0.08 ha (0.25 ac) wetland

Success Standards and Sampling Objectives
Third year success standards listed below were excerpted from the *Wetland Mitigation Plan Supplement for Pierce County Wetland Management Regulations SR 706, 305th Ave East to Anderson/Kernahan Roads* (WSDOT Olympic Region 1995). Companion sampling objectives follow where appropriate. A complete text of the success standards for this site is presented in Appendix C.

Success Standard 1:
After three years (2001) the wetland will have 75% survival of planted species. Facultative or wetter species (planted and naturally colonizing) will have 75% or greater aerial cover.

Sampling Objective 1A
To be 80% confident the survival estimate for planted trees and shrubs in the wetland of the SR 706 Ashford mitigation site is within 20% of the true value.

Sampling Objective 1B
To be 80% confident the aerial cover estimate for all facultative and wetter plant species (planted and naturally colonizing) in the wetland of the SR 706 Ashford mitigation site is within 20% of the true value.

Success Standard 2:
Soil saturation at or near the surface in most years as indicated by the development of hydric soil characteristics.

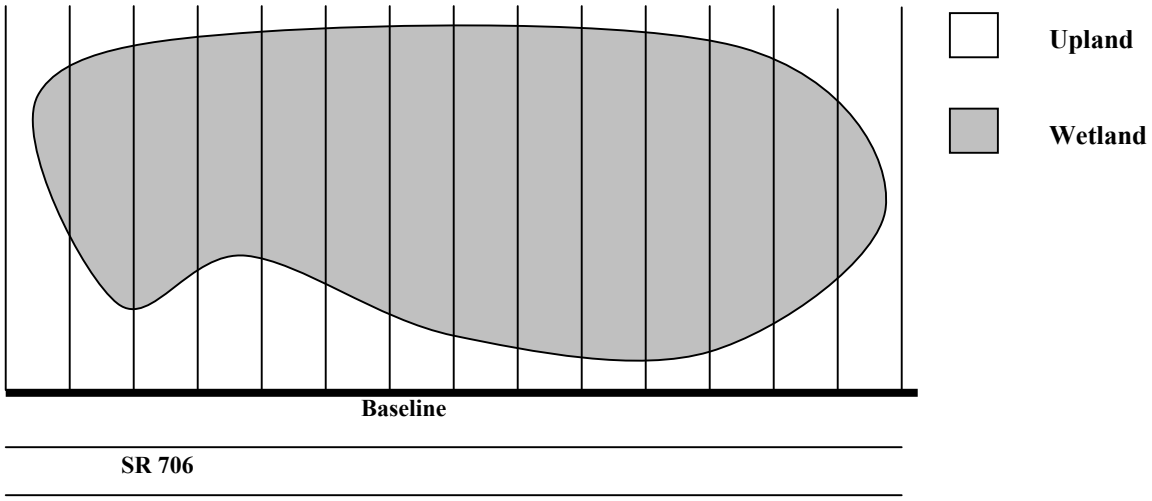
Success Standard 3:
Establishment and growth of the species planted that were in part selected to provide a food resource for wildlife species.

Success Standard 4:
The presence of wildlife species utilizing the site will be noted during the monitoring visits. Recording of mammals will be through incidental observation of individuals or signs. Stable or increasing presence of wetland dependent bird species during the bird surveys will indicate utilization by the target species.

Success Standard 5:
Develop amphibian habitat, principally terrestrial foraging habitat. Some breeding habitat may be established for species that do not exclusively use deep open water areas such as the Pacific treefrog. Positive indicators of success include on-site verification of presence, and successful establishment of wetland habitat.

Methods
In order to evaluate the vegetative community, a baseline located parallel to SR 706 was established. Twenty-five temporary sampling transects were placed perpendicular to the baseline using a systematic random sampling method (Figure 8).

Figure 8. SR 706 Ashford Mitigation Site 2001Sample Design Sketch.



Survival of woody species in the wetland and upland buffer was evaluated by placing 58 quadrats (1 × 6m) along transects using a simple random sampling method (Success Standard 1). Each planted tree and shrub observed within the quadrats was identified to species and recorded as alive, stressed, or dead.

Cover of facultative and wetter species within the wetland plant community was evaluated by randomly positioning twenty-four 20-meter point-line sample units (40 points each) along sampling transects (Success Standard 1).

Sample size analysis confirmed that sufficient sampling had been completed based on sampling objectives and the desired level of statistical confidence. The following equation was used to perform this analysis (Elzinga et al. 1998).

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[8]
n = unadjusted sample size

To evaluate wetland hydrology for Success Standard 2, hydrological field indicators were recorded during each site visit.

[8] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

To evaluate wildlife support functions at this site (Success Standard 4), 3 bird surveys were conducted at the mitigation site between May and June. Species richness and relative abundance were recorded.

Species diversity indices (H) were calculated from bird survey data using the Shannon-Wiener function (Krebs 1999). A mean annual species diversity index was calculated for 2000 and 2001.

$$H' = -\sum_{i=1}^{s} (p_i)(\log p_i)$$

H' = index of species diversity
s = number of species
p_i = proportion of sample belonging to ith species

The following t test was used to test the null hypothesis that mean annual diversity indices from 2000 and 2001 are equal (Zar 1999).

$$t = \frac{H_1' - H_2'}{S_{H_1' - H_2'}}$$

H' = index of species diversity
$S_{H_1' - H_2'}$ = standard error of the difference between species diversity indices $H_1^{'}$ and $H_2^{'}$

An amphibian survey was conducted in April 2001. A call survey and area search were completed in an effort to document amphibian presence in terrestrial environments. A qualitative habitat suitability assessment was made to determine the likelihood of amphibians using the mitigation site.

Results and Discussion

The mean survival estimate of planted trees and shrubs in the wetland and upland buffer zones was 97% (CI 0.99 ± 0.04). Although this value exceeds the 80% threshold required in Success Standard 1, it does not account for plants that may have vanished due to deer and elk browsing. A qualitative evaluation, however, indicated that a satisfactory level of upland and scrub-shrub plantings has been established at the mitigation site. The woody species community is also being augmented though natural colonization of *Salix* spp. (willows) as shown in the photo (Figure 9).

The mean aerial cover estimate for all facultative and wetter species in the scrub-shrub and emergent wetland zones was 96% (CI 0.80 ± 0.20), well above the 75% requirement specified in Success Standard 1. *Deschampsia caespitosa* (tufted hairgrass) and *Agrostis capillaris* (colonial bentgrass) dominate the wetland plant community providing 43% (CI 0.80 ± 0.20) and 37% (CI 0.80 ± 0.20) aerial cover, respectively.

Figure 9. SR 706 Ashford (July 2001).

Less than a decimeter of water was present at the south end of the site in April. Due to the short hydroperiod observed in 2001, the soil was not examined for hydric characteristics. Soil monitoring will resume in 2002.

Values for bird species diversity indicate no significant statistical change ($P = 0.901$) from 2000 to 2001 (Table 2) (Success Standard 4). Survey data shows most birds were observed along the site perimeter in the adjacent mature forest and upland pasture. Few birds were observed in central portions of the mitigation site. With further development of the wetland plant community, these results could change. Presence of *Oemleria cerasiformis* (Indian plum), *Mahonia aquifolium* (Oregon grape), and *Cornus sericea* (red-osier dogwood) was noted during vegetation surveys. These species provide a potential future food source and nest sites for birds and other wildlife species (Success Standard 3).

Table 2. Species diversity data at the SR 706 Ashford mitigation site (2000-2001)

Species Diversity Index	SR 706 Ashford 2000	SR 706 Ashford 2001
Mean	0.953	0.943
Standard Error	0.002	0.104
Range	0.950 – 0.957	0.754 – 1.113

Common Yellowthroats were observed on site in 2000 and 2001. Common Yellowthroats use wetlands as primary feeding, breeding, and nesting habitat, and they are considered to be a wetland dependent species in the state of Washington (Thomas 1979; Erhlich et al. 1988; Smith et al. 1997). Other bird species known to favor wetland habitats were observed on site this year. These birds include the Willow Flycatcher and Wilson's Warbler. These observations suggest utilization of the site by target species (Success Standard 4).

Black-tailed deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) were observed on site in 2001. Elk rubs, scat, and plant herbivory provide additional evidence of wildlife use (Success Standards 3 and 4).

A habitat suitability assessment indicates the site does not presently provide adequate shelter and terrestrial foraging habitat for amphibians due to a lack of woody debris, leaf litter, and well-developed layers of vegetation in the buffer. Funnel traps were not set during the amphibian breeding season (March-June) due to insufficient water. A call survey and area search did not detect amphibian presence at the site.

Management Activities

The site was replanted with *Abies grandis* (grand fir), *Mahonia aquifolium* (Oregon grape), *Alnus rubra* (red alder), and *Salix* spp. (willow stakes) in November 2000.
In June 2001, staff from the Olympic Region conducted mechanical brush removal on the site, mechanically weeded, and placed bark mulch around the planted trees and shrubs.

APPENDICES

Appendix A

SR 12 Black River Informal Success Standards

Monitoring tasks and associated management and sampling objectives were developed from the General Mitigation Strategy contained in the *SR 12 Vicinity Black River Bridge & SR 12 Vicinity Moon Road Combined Conceptual Wetland Mitigation Plan* (Russell 1998) and in consultation with Regional Staff. Permitting agencies did not require formal success standards. The criteria addressed this year are identified in **bold** font. Other tasks will be addressed in the indicated monitoring year.

Standard #1:
100% survival (or replacement) of trees and shrubs at the end of year one. Non-invasive volunteer species are acceptable in all zones and may be used in estimating percent cover of emergent species and credited toward survival of planted trees and shrubs.

Standard #2:
Vegetative success must equal or exceed 80 percent survival of planted trees and shrubs by the end of year three, or additional planting (and monitoring) to achieve such.

Standard #3:
Hydrology (within 12 inches of the soil surface) within the wetland creation area must be present for at least 12.5% of the growing season (consecutive).

Standard #4:
Cover of reed canarygrass, or other invasive species may not exceed 20 percent of the total wetland area at any time during years one through five.

Appendix B

SR 101 Sequim Success Standards

Monitoring objectives for the Sequim mitigation site were developed from success standards described in the Sequim Bypass Corridor Environmental Mitigation Plan (Ward and Schlatter 1997). The standards addressed this year are identified in **bold** font. Other standards and contingencies will be addressed in the indicated monitoring year.

Goals, Objectives & Standards

The following functions have been identified as important for the Sequim mitigation site.

1. Wildlife Habitat
2. Fisheries Habitat
3. Water Quality Improvement
4. Base flow support for Bell Creek

Of these four functions, it was decided that while #4 was very important, it was difficult to quantify as a performance standard, thus it was not included as a goal or performance standard in the mitigation plan.

The following are included as goals, objectives and performance standards.

Goals

To restore, preserve, and enhance wetlands on 23.25 ha (57.43 acres) site. An existing approximately 6.88 ha (17 acres) forested wetland will be preserved. Approximately 13.36 ha (33 acres) of wetland and wildlife habitat will be restored and enhanced. 3.24 ha (8 acres) will be a site buffer and riparian corridor. Emergent and open water habitats will be added to complement the existing shrub and forested wetland habitats to increase wildlife habitat diversity and enhance anadromous fish habitat. The site will be protected by a vegetated buffer along the southern end of the site and will be fenced to exclude cattle, improving the water quality in the wetlands.

Objective A

Restore 13.36 ha (33 acres) of the site to wetland conditions.

Standard A-1

A minimum of 10.12 ha (25 acres) will be restored to wetland conditions as determined by a wetland delineation completed in Year 5.

Methods:

The wetland shall be reestablished by installing ditch plugs and excavating shallow level spreader ditches to restore the wetland hydrology to the site.

Monitoring:
The delineation shall confirm the presence of hydrology. Hydrology will be monitored during the monitoring period.

Objective B
Increase wildlife habitat types and diversity by providing habitat for amphibians, increase structural diversity for birds, and by installing habitat structures.

Standard B-1
By Year 5 the site will provide suitable breeding habitat for frogs and salamanders. Species presence will be documented by live capture of adults or larvae, or observation of adults, larvae or egg masses.

Methods:
Excavate shallow ponds and plant a diversity of emergent species, providing a variety of stem diameters and water depths for egg deposition. Install plugs in ditches to allow for the creation of additional breeding areas.

Monitoring:
Use the appropriate technique depending upon the time of year. Egg mass surveys can be completed during the breeding season, or larvae can be trapped or dip-netted during the larval rearing season, or adults can be observed year-round or during the breeding season.

Standard B-2
Achieve a minimum of 70 percent survival of tree and shrub plantings by the end of Monitoring Year 1 on the site in both the wetland and buffer area.

Methods:
Create shrub and forested habitat areas within the existing pasture by planting groups of trees and shrubs. Establish a buffer along the southern portion of the site.

Monitoring:
Count number of dead and live tree and shrub seedlings.

Standard B-3
Install by the end of Monitoring Year 1 a minimum of 5 snags as perch trees, a minimum of 5 large woody debris piles and at least 10 bat boxes.

Methods:
Install according to plans.

Monitoring:
Document presence at completion of construction. Locate structures on as-built plans. While no specific monitoring of use is required, visual inspection of each bat box for guano and inspection of the ground under each perch tree for whitewash and pellets during the site inspections should be done opportunistically.

Objective C
Create and enhance fish habitat in Bell Creek.

Standard C-1
By the end of Monitoring Year 1, 75% of relocated Bell Creek will be a pool and riffle complex.

Methods:
Relocate Bell Creek according to the plans.

Monitoring:
Complete the following measurements on Bell Creek, total relocated length, length of each pool, and length of each riffle.

Standard C-2
Install a minimum of 20 instream structures to provide cover for fish by Monitoring Year 1.

Methods:
Installation of structures will occur according to plan.

Monitoring:
Count number of installed structures in Monitoring Year 1.

Standard C-3
Provide a riparian corridor along Bell Creek which provides some shade along a minimum of 40 percent of the stream corridor after 10 years.

Methods:
Plant a riparian community along the banks of relocated Bell Creek.

Monitoring:
Measure the total length of the relocated creek, and measure length of all riparian areas supporting vegetation over three feet tall to determine percent of stream corridor which is shaded.

Objective D
Reduce the opportunity of the water in the on-site portion of Bell creek and in the on-site portion of the wetland to become polluted with nitrates from cow manure.

Standard D-1
Exclude cattle from the mitigation site.

Methods:
Fence site with a cattle proof fence where there are active pastures adjacent.

Monitoring:
Visually inspect the site for cattle or signs of cattle intrusion.

Appendix C

SR 706 Ashford Success Standards

The following goals, objectives and success standards are excerpted from the *Wetland Mitigation Plan Supplement for Pierce County Wetland Management Regulations SR 706 305th Avenue East to Anderson/Kernahan Roads* (WSDOT Olympic Region 1995). The standards addressed this year are identified in **bold** font. Other standards and contingencies will be addressed in the indicated monitoring year.

Goals

The goals of this wetland compensation site are: (1) to create 0.6 acre of the physical environment necessary to support and promote the development of wetland characteristics; and (2) to compensate for the wetland functions and values that will be lost due to filling 0.315 acre of wetland during construction of the roadway improvements.

Objectives and Performance Standards

Hydrology

Objective 1 Establish wetland hydrology on 0.6 acre of existing pasture through evacuation and recontouring the existing ground.

Performance Standard: Soil saturation at or near the surface in most years as indicated by the development of hydric soil characteristics.

Objective 2 The site is located adjacent to the roadway, but it will not receive any runoff from the road. Because of the plan to utilize water from upgradient fields and swales that are currently used as pasture, the dense stands of vegetation that will be established will help facilitate the treatment of water within the wetlands. The vegetation will help attenuate flows and allow for increased groundwater recharge. The wetland will also provide sediment trapping capability and nutrient retention and transformation from the upgradient sources

Performance Standard 1: An increase in potential stormwater storage will be confirmed by as-built surveys of the creation site following construction.

Performance Standard 2: Establishment of dense stands of vegetation and flat grades to facilitate flow attenuation, nutrient and sediment retention, and capability for groundwater

recharge. Will meet standard if grade is per plan and Vegetation Performance Standards (see following Section) are met.

Vegetation

Objective 1 The wetland areas created in the compensation site will develop as emergent/scrub-shrub and eventually forested areas over time.

Performance Standard 1: After one year wetland will have 95% survival of planted tree and shrub species. Recruitment of native species is expected and should increase the overall aerial coverage of wetland plants.

Performance Standard 2: **After three years wetland will have 75% survival of planted species. Facultative or wetter species (planted and/naturally colonizing) will have 75% or greater aerial cover. Conformance will be measured through surveys at permanent monitoring plots.**

Performance Standard 3: After five years the wetland portion of the site will have about 35-50% palustrine scrub/shrub and 50-65% palustrine emergent wetland area as measured by aerial coverage. Scrub/shrub is considered all woody species <3 inches dbh. Conformance will be measured through surveys at permanent monitoring plots.

Performance Standard 4: After five years approximately 90% of the species present should be native species. Conformance will be measured through surveys at permanent monitoring plots.

Objective 2 An area of 1.42 acres will be preserved and enhanced as upland buffer between the wetland creation and preservation areas and adjacent land uses.

Performance Standard 1: Buffer planted per plan with greater than 75% survival of planted species over 5 years.

Habitat

Objective 1 This wetland area should provide some habitat for wildlife species, principally birds and small mammals. Because of the location in a rural setting, the site will be suitable for large mammals usage. There was noted high elk use of surrounding habitat areas, so it is expected that the wetland, as it develops, will also be suitable elk habitat. Because of the small size of the site, it is not expected to fulfill the complete habitat needs for any individual species. The site is expected to by use primarily as foraging habitat.

Performance Standard 1: **Establishment and growth of the species planted that were in part selected to provide a food resource for wildlife species.**

Performance Standard 2: **The presence of wildlife species utilizing the site will be noted during the monitoring visits. Recording of mammals will be through incidental observation of individuals or signs. Stable or increasing presence of wetland dependent bird species during the bird surveys will indicate utilization by the target species.**

Objective 2 The wetland will be suitable for some species of amphibians. Because the mitigation site is not connected to a creek, it will not be of value to downstream fisheries.

Performance Standard 1 **Development of amphibian habitat, principally terrestrial foraging habitat. Some breeding habitat may be established for species that do not exclusively use deep open water areas such as the Pacific treefrog. Positive indicators of success include on-site verification of presence, and successful establishment of wetland habitat.**

Human Value Functions

Objective 1 Create a wetland that is congruous with the landscape and in harmony with the overall viewshed as the site will be visible from the highway which is the corridor leading the Mt. Rainer National Park

Performance Standard: Site development per plan.

Weed Control

Weed control measures for the SR 706 project will entail the eradication of undesirable vegetation prior to planting or soil amendment incorporation. The method of application, type of herbicide used, and timing of application will depend on site-specific situations. All applications will be performed by a licensed applicator and be done in compliance with the label and WA State Department of Agriculture rules and regulations.

After the sites have been planted, the use of herbicide will be limited to eradication of unwanted or exotic vegetation. As the plant material becomes established the use of herbicides will be restricted to controlling noxious weeds and other exotic species.

It is WSDOT's policy to utilize an Integrated Pest Management (IPM) approach to weed control. The use of herbicide will be limited to the extent absolutely required. In many situations hand pulling of individual weeds or other types of mechanical means will be adequate to control the unwanted vegetation. The goal of this department is to control only the amount of herbaceous material necessary to allow the plantings to become established and compete on their own and to keep exotics species from invading the sites.

Additional Permit Requirements:
The Pierce County Permit states that "at the end of the monitoring period, the boundaries of the created wetland shall be surveyed, to demonstrate whether or not the mitigation acreage goals have been met".

Glossary of Terms

Abundance (total) – the total number of individuals, cover, frequency of occurrence, volume, or biomass of a species, or group of species, within a given area.

Accuracy – the closeness of a measured or computed value to its true value.

Adaptive management – the process of linking ecological management within a learning framework (Elzinga et al. 1998).

Aerial cover – is the amount of ground covered by vegetation of a particular species or suite of species when viewed from above. Aerial cover is generally expressed as a percentage. This is typically obtained from point-line, point-frame, or line intercept data.

Areal estimates – are made using the mapped boundary of a feature as viewed from above. Areal estimates are a measure of area recorded as a number from 0 to 100, and not as a fraction or percent (Hruby et al. 1999).

Aquatic vegetation – includes submerged and rooted (*Elodea*, *Characeae*, *Myriophyllum*) or floating (non-rooted) plants (*Lemna, Azolla, Wolfia*). For compliance purposes, these plants are not included in cover estimates. Vascular, rooted, floating-leaved plants *are* included in cover estimates (e.g., *Nuphar, Potamogeton*).

Bare ground – an area that can support, but does not presently support vascular vegetation.

Confidence interval (CI) – is an estimate of precision around a sample mean. A confidence interval includes confidence level and confidence interval half-width. Expressed as: CI 0.80 ± 0.20.

Canopy cover – the coverage of foliage canopy (herbaceous or woody species) per unit ground area**.**

Community – a group of populations of species living together in a given place and time.

Cryptogam – any of the *Cryptogamia*, an old primary division of plants comprising those without true flowers and seeds including ferns, mosses, and thallophytes (algae, fungi, and lichen).

Density – the number of individuals, stems, or other counting unit per unit area.

Densitometer – a hollow T-shaped polyvinyl chloride (PVC) device that includes horizontal and vertical leveling and a mirror to locate a precise vertical point in space

either directly above or directly below the densitometer. Target vegetation intersecting the vertical line of sight through the instrument is recorded.
Herbaceous – with characteristics of an herb; an annual, biennial, or perennial plant that is leaflike in color or texture, and not woody.

Hydric soils – soils formed under the conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

Invasive – A plant that interferes with management objectives on a specific site at a specific point in time (Whitson et al. 2001).

Macroplot – usually refers to a relatively large sampling area in which sub-sampling will be conducted, often using quadrats and/or transects (Elzinga et al. 1998).

Open water – an area intended to be non-vegetated and permanently inundated as described in the site mitigation or planting plan.

Point frame – is a square or rectangular quadrat that consists of a set of identified points used to collect vegetation data.

Point Intercept Device – a tripod that contains a level and supports a rod that can also be leveled and then lowered vertically to intercept target vegetation at an identified point.

Point-line – linear series of points comprising a sample unit.

Point quadrat (points) – a single point, used to sample vegetation data. The point quadrat is theoretically dimensionless.

Population (biological) – all individuals of one or more species within a specific area at a particular time.

Population (statistical) – the complete set of individual objects (sampling units) about which you want to make inferences.

Precision – the closeness of repeated measurements of the same value.

Quadrat – an area delimited for sampling flora or fauna; the sampling frame itself.

Random sampling – sampling units drawn randomly from the population of interest.

Relative abundance – the number of individuals per unit of sampling effort.

Relative Cover – The proportion of specific target vegetative cover compared to that of all the vegetative species in the community combined (Brower et al. 1998).

Restricted Random Sampling Method – a sampling method that divides the population of interest into equal-sized segments. In each segment, a single sampling unit is randomly positioned. Sampling units are then analyzed as if they were part of a simple random sample (Elzinga et al. 1998).

Sample – a subset of the total possible number of sampling units in a statistical population.

Sample size equations – use sample unit mean and standard deviation to determine if data have been collected from enough sample units to meet the sampling objectives.

Sample standard deviation – a value indicating how similar each individual observation is to the sample mean.

Sampling – the act or process of selecting a part of something with the intent of showing the quality, style, or nature of the whole.

Sampling objective – a clearly articulated goal for the measurement of an ecological condition or change value (Elzinga et al. 1998). Sampling objectives are generated from success standards. Elements of a sampling objective include the desired confidence level and confidence interval half-width, or the acceptable false-change error and acceptable missed-change error level.

Sampling units – the individual objects that collectively make up a statistical population.

Standard deviation – a measure of how similar each individual observation is to the overall mean value.

Shrub – a woody plant which at maturity is usually less than 6m (20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Species richness – the total number of species observed on a site.

Structures – any structure that is not expected to support vegetation during the monitoring period. Structures may include habitat structures, rocks, and other artifacts.

Stratified Random Sampling Method – The population of interest is divided into two or more groups (strata) prior to sampling. Within each stratum the sample units are the same. Sample units from different strata may or may not be identical. Random samples are obtained within each group (Elzinga et al. 1998).

Systematic Random Sampling Method – the regular placement of quadrats, points, or lines along a sampling transect following a random start.

Transect – a line to survey the distributions or abundance of organisms across an area.

Tree – a woody plant that at maturity is usually 6m (20 feet) or more in height and generally has a single trunk, unbranched for 1m or more above ground, and more or less definite crown (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Vegetation structure – the physical or structural description of the plant community (e.g. the relative biomass in canopy layers), generally independent of particular species composition.

Wetland-dependent species (birds) – restricted in temporal or spatial distribution to wetlands based on an intrinsic feature or features of the environment (Finch 1989).

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